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Same old song: On the macroeconomic and distributional effects of leaving a Low Interest Rate Environment

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Abstract

This paper analyzes the macroeconomic and distributional implications of central banks' decisions to raise interest rates after a prolonged period at near the Zero Lower Bound (ZLB). The main goal of our study is to assess the interaction between monetary policy, inequality, and financial fragility, in a financialized economic system. Financialization is here portrayed as the presence in the economy of complex financial products, i.e., asset-backed securities, produced via the securitization of banks' loans. We do so in the context of a hybrid Agent-Based Model (ABM). We first compare the prevailing macroeconomic and financial features of a low interest rate environment (LIRE) with respect to a "Great Moderation"(GM)-like setting. As expected, we show that LIRE tends to stimulate faster growth and higher employment, and to reduce income and wealth inequality, as well as (poor) households' indebtedness. Consistent with existing empirical literature, this comes at the cost of higher inflation and some signs of financial system's fragility, i.e., lower banks' profitability and Capital Adequacy Ratio (CAR), and higher "search for risk" given by credit extension to poorer households. We then show that increases in the central bank's policy rate, as motivated by the central bank's willingness to reduce inflation, effectively curb price dynamics and accomplish with central bank's inflation targeting mandate. Higher interest rates also improve commercial banks' CAR and profitability. However, they also cause a pronounced increase in non-performing loans (stronger than what possibly observed in a GM scenario) and some worrisome macro-financial dynamics. In fact, higher interest rates give rise to higher households' and overall economy indebtedness as allowed by wealthier households' demand for high-yield complex financial products and mounting securitization. We finally show how financialization structurally changes the functioning of the economy and the behavior of central banks. Financialization actually contributes to create a (private sector) debt-led economy, which becomes structurally more resistant to central bank's attempts to control inflation. Central bank's reaction in terms of higher interest rates could likely come with perverse distributional consequences.

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1 Introduction

The outbreak of the 2007-2008 financial crisis led central banks of leading developed economies to adopt extraordinary policies. At the beginning, monetary authorities likely conceived them as temporary measures backstopping national and global financial systems against complete collapse. Through time, they then became central banks' main recipe against protracted economic stagnation (depression) and too-low inflation records (deflation). Whilst central banks' balance sheets ballooned (due to quantity easing), nominal interest rates dropped down to zero or even entered negative territory.

The economic literature, technical reports by monetary institutions mostly, has shown increasing interest in understanding the implications of what has been labelled a low(-for-long) interest rate environment (LIRE). Focus is prevalently about LIRE's effects over financial *conditions*, i.e., the evolution of some relevant financial variables in the context of persistently low interest rates, and/or financial sector's *vulnerabilities*, i.e., possible exposure to losses due to shocks or, perhaps, the progressive exit from LIRE itself (see, for instance BIS, 2018; Brei et al., 2019; ESRB, 2016, 2021).[1] Quick and abrupt increases in policy rates implemented by most central banks since the beginning of 2022 seem to justify this interest more than ever.[2]

As said, the contributions just mentioned adopt an industry-level approach. They look at how LIRE may have changed the business model of financial institutions (ex: commercial banks' move away from the retail loan segment to market trading) or may have been source of financial sector's fragility (ex: lower banks' profitability or higher "search for risk"). Our work aims at extending such analysis by following a broader macro-financial perspective. Our goal is to study how LIRE may affect the macroeconomy at large by also influencing inflation and unemployment dynamics, income and wealth distribution, the level of indebtedness of relevant non-financial *institutional* sectors (i.e. households and non-financial firms) and of the economy as a whole. Other way around, we put at the centre of our study the complex *interaction* between the financial sector, the real economy, and policy making by monetary institutions that characterizes modern financialized economies. In this sense, a corollary aspect of our study is to shed light on the role that securitization and the production of complex financial products such as asset-backed securities (ABS) play in shaping the functioning of the financial sector, the joint evolution of financial and real variables (ex: private indebtedness, unemployment and inflation) and, ultimately, the monetary policy stance pursued by the central bank.

We conduct our analysis by developing a complex hybrid Agent-Based (AB) Stock-Flow-Consitent (SFC) model that features multiple financial sectors and heterogenous households. Following Botta et al. (2021) and Botta et al. (2022), this methodology allows us to keep in due account multiple feedbacks in the continuous interactions between heterogenous households, the productive non-financial sector, and financial institutions that endogenously create banks' money. However, with respect to Botta et al. (2021, 2022), we now explicitly model monetary policy, i.e., central bank-led changes in the benchmark policy rate and, hence, in the overall cost of credit in the economy. In this context, we investigate three main points. First, we compare the functioning of the economy and the evolution of main real, financial and distributive variables under LIRE with respect to a "Great Moderation"(GM)-like scenario, with the two scenarios differing only in the policy rate. Second, we look at the macro-financial consequences of a series of increases in the central bank's policy rate.[3] Third, we analyze the role of finanzialization, here portrayed as securitization and production of ABSs, in shaping how the system works and how central bank responds to inflation dynamics. We obtain three main results.

[1] For a discussion of the different but interrelated meanings of financial *conditions*, financial *vulnerability* and financial *risk*, see Malovana et al. (2022).

[2] To be fair, the FED already planted a soft and gradual rise in the FED fund rate back in 2015 when US economic conditions progressively improved out of post-2008 stagnation. It returned back to the Zero-Lowe-Bound (ZLB) with the outbreak of Covid-19. The recent steep increase in inflation records as due to breakdown in global supply chain and the effects of the Ukraine war over the prices of primary commodity has eventually convinced the FED and other major central banks to now implement aggressive restrictive monetary policies.

[3] The analysis of the causes behind the most recent rise in inflation and of ensuing monetary policy reactions by central banks in advanced economies is beyond the scope of this paper. Consistent with the focus of the contributions about LIRE mentioned above, our interest is on the wide macro-financial implications of central banks' decision to leave LIRE for whatever reasons this decision is taken. As such, when modeling central bank's policy choice, we will take the simplest way possible and we will just consider exogenous changes in central bank's policy rate target.

First, consistent with the empirical literature mentioned above, we confirm that LIRE may effectively give rise to some fragility in the financial industry, in the commercial bank sector more specifically. Indeed, lower interest rates' margins squeeze commercial banks' profitability, reduce their capital adequacy ratio and make compliance with capital adequacy requirements more complicated. Moreover, LIRE tends to increase commercial banks' "search for risk", i.e., extension of credit to poorer and more financially vulnerable households that would be normally rationed but pay higher interest rates on received loans. Despite such potential sources of financial risks, LIRE also helps to reduce both households' and non-financial firms' indebtedness by cutting debt service with respect to what observed in a GM-like scenario. Also, securitization develops at a much lower scale. Moreover, as expected, LIRE tends to support faster growth, lower unemployment and more equal income and wealth distribution, albeit at the cost of higher inflation. In the end, LIRE may somehow cause some fragilities to emerge and concentrate in some sectors of the financial industry (i.e. the commercial bank sector), but it could improve the macro-financial stability of the economy as a whole.

Second, central bank's decision to exit from LIRE and increase interest rates is in itself a possible source of macro-financial vulnerability. Financial sector's standard performance indicators certainly improve. However, rising interest rates may also cause a substantial rise in non-performing loans on households' debt. Poorer and more fragile households immediately go under water. We do not observe such a sudden rise in households' financial distress in a GM setting (even though on average, the *level* of non-performing loans is higher in the GM scenario than under the LIRE). More than that, aggregate private debt increases instead of declining. In fact, rising interest rates allow for the production of more remunerative financial products, namely ABS, purchased by and sold to wealthy households on financial markets. Securitization speeds up. This in turn enables commercial banks to extend more loans to more indebted (and more financially unsound) households and non-financial firms.

Third, financialization fundamentally alters the functioning of the economy. Whilst it does not play any significant role when interest rates are close to the ZLB, it instead enables the creation of a (private) debt-led economy at higher or rising interest rates. Consistent with Jorda et al. (2017), it may certainly spur growth and reduce unemployment. However, this comes at the cost of a much higher level of (private) sector indebtedness. Moreover, it increases volatility in credit's provision, i.e., a likely fundamental source of macroeconomic instability in a debt-led economy. Last but not least, financialization tends to counteract and frustrate central bank's attempts of curbing inflation. Central bank can obviously react to this by adopting a persistently more restrictive monetary policy stance. Eventually, all this may describe an economic system which is structurally more benevolent to rentiers and afflicted by higher inequality standards: the same old song over the last four decades.

The paper is organized as follows. Section 2 presents a brief review of the empirical and theoretical literature about LIRE. Section 3 describes the hybrid AB-SFC model through which we analyze the macro-financial and distributive implications of LIRE with respect the pre-2007 GM scenario. Section 4 presents the results of our study. Section 5 concludes.

2 Literature review

Monetary policy is a fundamental instrument in the hands of policy makers. Under the so-called new consensus macroeconomics, it even got primacy as leading, and almost exclusive, tool for controlling inflation and stabilizing the business cycle (Rochon and Setterfield, 2007). Central banks adopted bold actions even before the last financial crisis. Volcker's monetarist interest rate hike and the so-called "Greenspan put" are just two examples. Despite this, monetary responses to the 2007-2008 financial shock and to the economic stagnation of the following years certainly qualify as extraordinary and unprecedented. It is so because of the amount of asset purchases and liquidity injection carried out by the most important central banks worldwide, for the corresponding expansion in central banks' balance sheets, for the extremely low (even negative) levels reached by interest rates, for the communication style and for the duration in time and spread through countries of such policies.

The economic literature has coined the term "low(-for-long) interest rate environment" (LIRE) in order to describe such post-2008 protracted period of historically low interest rates. More precisely, this expression refers to central banks' actions in advanced countries to bring and keep short-term nominal interest rates close to zero (or even below it) via changes (i.e. cuts) in their target policy rate.

The vast majority of still small but expanding literature about LIRE consists of empirical works analyzing their effects upon some relevant financial variables. Borio et al. (2017), Claessens et al. (2018), Bats et al. (2020), and Ampudia and Van den Heuvel (2022), for instance, all study how monetary policy, namely further cuts in central bank's policy rate, affects banks' profitability in a low (but positive) or negative interest rate setting. Borio et al. (2017), Altavilla et al. (2017), and Claessens et al. (2018) look 'backward' at realized profits only. Altavilla et al. (2017), as well as Bats et al. (2020) and Ampudia and Van den Heuvel (2022), extend the analysis to *expected* future banks' profits as captured by banks' stock market values. Most of these studies find that reductions in central banks' policy rate, if carried out under LIRE, prompt a decrease in banks' profitability, both realized and expected. This latter result is in contrast with previous empirical evidence according to which conventional expansionary monetary policy, when implemented in a more traditional interest rate setting, would raise banks' stock market values by feeding economic activity and, hence, improving banks' prospected profitability (see Bats et al., 2020; Ampudia and Van den Heuvel, 2022). Borio et al. (2017) go further and claim that the positive relation between central banks' policy rate and banks' profitability is highly non-linear. Given its concave nature, cuts in central banks' policy rate are not passed through banks' net interest rate margins when interest rates are already low. Therefore banks' profits may be severely hit under LIRE. Altavilla et al. (2017) offer a partially different and more positive perspective. On the one hand, they empirically find and admit that LIRE could actually reduce banks' profitability. On the other hand, however, such effect seems to be statistically small. Low-for-long interest rates would actually take *very* long to hurt banks. Moreover, such direct negative effects of LIRE over banks' profitability might be largely compensated (if not neutralized) by LIRE-induced improvements in the overall economic performance.[4]

BIS (2018), Brei et al. (2019), ESRB (2016) and ESRB (2021) embed the link between LIRE and banks' profitability in a wider analysis about LIRE's effects over the functioning of the financial industry and ensuing implications for financial sector's stability. They provide a quite rich description of the possible LIRE's impact over multiple financial variables. On top of noting once more the negative relation between LIRE and banks' profitability, they also stress how banks could more hardly comply with regulation, capital adequacy requirements (CAR) in particular, when interest rates are persistently low. Indeed, lower banks' profitability will likely cause capital accumulation via retained earnings to slow down and CAR to decrease (with respect to, say, a more common higher interest rate setting). In lights of these facts, LIRE may induce banks to modify their business model. As to asset management, banks may move towards more market- and fee-based activities and (proportionally) reduce credit provision via retail loans. Moreover, they may become less risk adverse. According to ESRB (2021), banks have effectively increased their "search for yield" by financing riskier and more financially vulnerable economic units, among households and firms, in the attempt of compensating for averagely lower interest rate income. On the liability side, banks seem to rely more heavily on deposits rather than external funding, namely securitization (see Brei et al., 2019).

The macroeconomic implications of such dynamics in the finance industry are potentially wide. However, at the best of our knowledge, only a handful of papers has tried to gauge them, either empirically or theoretically. From an empirical point of view, Grimm et al. (2023) try to provide new empirical evidence about the role of prolonged periods of loose monetary policy as predictors of financial and macroeconomic crises. They adopt a mainstream "Wicksellian" approach and define loose monetary policy stance as a five-year window over which the real interest rate is one percentage point lower than the *natural* one, on average.[5] They find that loose monetary policy stances significantly increase the probability of subse-

[4] Altavilla et al. (2017) also stress that the negative effects of central bank's policy rate cuts over bank profitability largely disappear, i.e., turn statistically insignificant, if empirical analysis duly take into account for the indirect effects that such policy themselves may generate by influencing general macroeconomic expectations. According to Altavilla et al. (2022), such more benevolent perspective also applies to the case of negative interest rates. In fact, Altavilla et al. (2022) find high-quality banks being able to (at least partially) maintain their interest margin and, hence, profitability, by passing through negative interest rates on reserves over corporate deposits' rates.

[5] To be fair, goals, scope and time frame of Grimm et al. (2023) go well beyond the "simple" study of LIRE's macroeconomic effects. Their definition of loose monetary policy stance could actually not even include the most recent period of low interest rates, as it hinges upon the computation of the natural interest rate, a variable that is unobservable in reality and in the data. Nonetheless, we believe it might be important to mention this study as example of the most recent analyses about the link between (comparatively) historically low interest rates and macroeconomic dynamics.

quent financial (and economic) crises if they feed excessive credit expansion together with housing/stock exchange speculative bubbles.

From a theoretical point of view, Adrian (2020), Porcellacchia (2022) and Abadi et al. (2022) somehow try to depart from the "ceteris paribus" assumption adopted by some of the previous empirical works (Borio et al., 2017, for instance), as to general macroeconomic dynamics beyond pure financial variables.[6] Adrian (2020), for instance, presents a reduced-form four-equation New Keynesian (NK) model in which he formally describes the interaction between LIRE and endogenous risk-taking by financial institutions. His goal is to show how LIRE may stimulate faster and less volatile growth in the short-to-medium term at the cost of lower and more unstable macroeconomic dynamics in the long run. Porcellacchia (2022) and Abadi et al. (2022), in turn, focus on the effectiveness of monetary policy under LIRE. More specifically, both contributions try to model and quantify the idea of a *reversal* interest rate threshold below which additional interest rate cuts become contractionary and counterproductive for both credit and economic expansion. Consistent with most of the empirical literature reviewed above, the reversal interest rate emerges because, below a certain level, lower interest rates impair banks' profitability, their capital buffer and, hence, their capability to extend credit to the economy.[7]

Whilst the scope of their analysis is broader than most of the empirical literature discussed above, Adrian (2020) and Abadi et al. (2022) develop their studies based on relatively parsimonious macro-aggregated NK DSGE models. In the case of Adrian (2020), this implies that the interaction between real and financial variables still takes place and is modeled via quite abstract equations such as an extended Taylor-rule (including a new "financial condition" variable in central bank's setting of the short-term interest rate) or an endogenous "financial condition" function, whereby banks' search for yields responds to its previous values and to (present and expected) economic activity.[8] As such, Adrian (2020) does not embed financial-real joint dynamics in a theoretical framework that explicitly features multiple financial assets and liabilities, and describes the behavior of both credit institutions and borrowers into debt-credit relations. Abadi et al. (2022) certainly provide a more articulated description of financial mechanisms in their larger NK DSGE model. However, they still neglect possible macro implications of financial dynamics via their effects over distributional variables, namely income and wealth inequality. The co-evolution of financial and distributional dynamics is a distinguishing feature of modern financialized economies though (see Botta et al., 2021, 2022), as well as potential cause of macro-financial instability itself (see Rajan, 2010; Bordo and Meissner, 2012; Stockhammer, 2015; Kumhof et al., 2015, among other).

In the present paper, we try to fill those gaps and to study complex financial-real side dynamics when the economy works under LIRE. In order to do so, we build upon Botta et al. (2021, 2022) and develop a hybrid AB-SFC model, where all economic sectors are aggregated but households. On the one hand, heterogeneous households allow us to track the evolution of *personal* income and wealth inequality, and study how distributive dynamics influence households' consumption and financial behaviors (the decision to apply for banks' loans, for instance). They also enable us to analyze how LIRE may have structurally changed the behavior of banks by perhaps pushing them to take on board more risks and extend loans to more fragile households, presumably those at the bottom of income and wealth distribution. On the other hand, the SFC theoretical framework of our model permits the rigorous and explicit modeling of financial relations involving multiple assets and different financial institutions.

With respect to Botta et al. (2021, 2022), in this paper we more explicitly model central bank' monetary policy. More specifically, we aim at studying the effects of central bank's decision to change its

[6]It is by criticizing this assumption that Altavilla et al. (2017) believe most other empirical studies on this matter provide a somehow excessively harsh judgement of LIREs. According to them, 'the estimated [negative] impact can be substantially different when the endogenous reaction of the macro variables associated with the low interest rate environment is taken into account [...] Overall, the adverse impact of a protracted period of low rates on profitability is likely to be offset by the respective impact on loan loss provisions and intermediation volumes (Altavilla et al., 2017, p.18)'.

[7]See Gambacorta and Shin (2018) on the positive relation between banks' capital and the credit provision to the economy, hence the importance of banks' profitability and capital accumulation for the conduction of monetary policy.

[8]The Federal Reserve Bank of Chicago computes the National Financial Conditions Index as a weighted average of 105 financial variables (interest rate spreads, swaps, yields etc...). It is meant to provide a synthetic overview of the level of activity and liquidity in the financial system, including both market-based activities, traditional and shadow banking (see Adrian et al., 2019). Consistent with this, Adrian (2020) uses the "financial conditions" variable as a measure of "the cost of funding risky projects in the economy, that is, the price of risk (Adrian, 2020, p.6)".

policy rate when this is implemented in a low interest rate environment. In this sense, differently from Abadi et al. (2022) and Porcellacchia (2022), we are not interested in the effectiveness of new rounds of expansionary monetary policy and further cuts in the central bank's policy rate, perhaps bringing it below the *reversal* interest rate. We actually investigate the opposite, i.e., the evolution of financial and real side variables triggered by central bank's decision to (perhaps abruptly) increase its policy rate after a protracted period at the ZLB. We do so for two reasons. First, consistent with recent concerns expressed by the European Systemic Risk Board (see ESRB, 2021), we investigate how the economy may respond to a steep reversal in the monetary policy stance (and not in its effectiveness) given the potential systemic fragilities that may have built up under LIRE. Second, such an analysis seems to be more aligned with most recent stances adopted by most important central banks worldwide, which effectively gave rise to quick, substantial and repeated increases in their policy rates since the beginning of 2022.

Interestingly enough, the above analysis also enables us to shed some light on a novel aspect of central banking that, at the best of our knowledge, has not been put forward in previous contributions. In fact, we study how innovations in the financial system, namely the introduction/expansion of the securitizing system and the production of complex financial products such as ABS, may have altered how the economy as a whole, and inflation dynamics more specifically, react to changes in monetary policy. It goes without saying that such structural change in the functioning of the economy may imply equally permanent modifications in the monetary policy stance on average adopted by policy makers, with ensuing systemic consequences.

3 The model

In this paper, we analyze the macro-financial implications of leaving a LIRE. The interaction between monetary/financial variables and real-side ones, distributive variables included, is at the centre of our study. For this reason, we develop a hybrid SFC-AB model featuring multiple financial sectors and different financial assets. More specifically, we assume a closed economy that is composed of five sectors. There are four aggregate sectors: *non-financial firms, commercial banks, investment funds*, *and the government.* An additional sector, *Special Purpose Vehicles* appears in the accounting matrices (see Tables 1 and 2) but does not appear among the equations (see section 3.2) of the model as it is merely a passive actor used by banks to move a portion of their assets out of their balance sheet in the securitization process, and to divert the correspondent part of interest to the owners of ABSs. On top of government, the public sector also includes the central bank. As discussed above, monetary policy is modeled in the very simple central bank's decision to exogenously fix and move the base policy rate. As such, central bank does not appear in accounting matrices and in the set of behavioral equations below. The *households* sector is the only one populated by heterogenous agents. The inclusion of heterogeneous households in our model allows us to track the effects of LIRE and of a GM-like scenario (as well as of the move from the former to the latter) over a variety of macro dimensions: banks' search for risk (i.e. extension of credit to riskier households), credit rationing, households income and wealth inequality.

Table 1 shows the initial stocks of the economy and offers a first intuition of balance sheet interconnections among sectors. Five different assets (deposits, loans, shares, public bonds, and ABSs) are considered in a financial system characterised by (i) the presence, alongside commercial banks (i.e. B), of non-bank financial institutions - investment funds (i.e. IF), and special purpose vehicles (i.e. SPV) - and (ii) by the representation of securitization and the 'production' (Tori et al., 2023) of complex financial products (ABSs). As said, SPV is a *pass-through* actor, used by banks to move out their balance sheet a portion (z) of loans (L), which is transformed into ABSs and then sold to IF (see Table 2).

Households can get indebted via banks' loans to reach their desired levels of consumption and/or (financial) investment. They allocate their wealth either to deposits (for transitionary or precautionary reasons) or to IFs' shares. The latter are issued by IFs, which may be seen as households' gate of access to financial markets. Indeed, IFs collect funds by issuing, on demand, investment shares bought by households. In each period, the whole stock of collected funds is invested purchasing available financial assets, namely deposit, public bonds, and ABSs. Earnings on asset's holdings are entirely transferred to the owners of shares. Therefore, households receive a composite return, which combines interests on public bonds and, through ABSs, on securitized loans. They also receive dividends, which are distributed by both non-financial firms and commercial banks as part of their profits.

The rest of the financial structure of the economy is rather standard. Non-financial firms use banks loans as a source of external finance, and retained profits serve as complement to banks' loans in the financing of investment. Commercial banks, in turn, retain part (or the totality) of their profits in order to accumulate own funds (i.e. OF) and meet regulatory requirements. In each period, both banks and firms retain all current profits and distribute a part of those set aside in the period profit. For the social accounting, as portrayed by Table 2, the share of profits that will be distributed in the following period is hidden in the OF accounting item. In the behavioral equations though, they are made explicit and appear as dividends payable (see Equation 35 in Section 3.2). Finally, public bonds are issued by the government to finance its deficit. Following chapter 9 of Godley and Lavoie (2007), the revaluation of OF is accounted for in Table 3.

Given the complex set of choices and financial relations characterizing the model, the households sector in particular, here we avoid further layers of complexity by neglecting housing and mortgages as potential additional assets and liabilities, respectively. This obviously impedes us to consider in this model the relation between central bank's monetary policy, the determination of interest rates and possible housing (housing's price) boom-and-bust cycles. On top of keeping the model simpler, we take this modeling strategy for three reasons. First, the relation between central bank's (easy) monetary policy, (too-low) interest rates and housing (households' debt) bubbles still remains controversial. On the one hand, some recent contributions identify excessively expansionary monetary policy as possible source of financial instability by fueling housing bubbles and rises in households' debt (Grimm et al., 2023). However, the definition of overly expansionary monetary policy is based on the very elusive (and hardly measurable) concept of *natural* interest rate. Given post-2008 alleged decline in such rate (and the ensuing risk of "secular stagnation"), it is questionable whether, in the aftermath of the Great Financial Crisis (GFC), expansionary policy qualifies as too expansionary. On the other hand, a variety of previous contributions rebut the centrality of too-low interest rates in feeding housing bubbles (Fatas et al., 2009) and households' debt (Stockhammer and Wildauer, 2018). According to Bernanke (2010), financial innovations were major drivers of the last housing bubble, so that "regulatory and supervisory policies, rather than monetary policies, would have been more effective means of addressing the run-up in house prices" (Bernanke, 2010). Second, there is no clear evidence that a new housing bubble is under way as a consequence of the post-2008 LIRE, i.e., our period of interest. According to the 2021 ECB Financial Stability Review (ECB, 2021), residential estate's prices have been on the rise since 2016, but they never reached record level registered before 2008. On top of this, in the same time period, there has been a significant slowdown in the dynamics of commercial estate's prices. In reality, before the outbreak of Covid-19, consumer credit expanded more vigorously than mortgages. Third, despite excluding by assumption housing bubbles, the present model still admits for the possibility of financial bubbles to take place whenever households may decide to get indebted in order to invest in remunerative financial assets such as investments shares (and, indirectly, ABSs).

	Households	Banks	SPV	IF	Firms	Gov	Total
Deposits	$+D_H$	$-D$	$+D_{IF}$	$+D_{SPV}$	$+D_F$		0
Capital					$+K$		$+K$
Shares	$+Sh$			$-Sh$			0
Bonds		$+B_B$		$+B_{IF}$		$-B$	0
Loans	$-L_H$	$+(1-z)L$	$+zL$		$-L_F$		0
Derivatives			$-ABS$	$+ABS$			0
Own Funds	$+OF$	$-OF_B$			$-OF_F$		0

Table 1: Aggregate Balance Sheet (Initial Situation)

	Households	Banks		SPV		IF		Firms		Govt.	Σ
		CA	KA	CA	KA	CA	KA	CA	KA		
Consumption	$-C$	0	0	0	0	0	0	$+C$	0	0	0
Publ. Exp.	0	0	0	0	0	0	0	$+G$	0	$-G$	0
Investment	0	0	0	0	0	0	0	$+I$	$-I$	0	0
Wages	$+W$	0	0	0	0	0	0	$-W$	0	0	0
Dole	$+Do$	0	0	0	0	0	0	0	0	$-Do$	0
Taxes	$-T_H$	$-T_B$	0	0	0	0	0	$-T_F$	0	$+T$	0
Int. on Loans	$-i_H L_{H,t-1}$	$+i(1-z)L_{t-1}$	0	$+izL_{t-1}$	0	0	0	$-i_F L_{F,t-1}$	0	0	0
Ret. on Deriv.	0	0	0	$-fABS_{t-1}$	0	$+fABS_{t-1}$	0	0	0	0	0
Ret. on Shares	$+rSh_{t-1}$	0	0	0		$-rSh_{t-1}$	0	0	0	0	0
Int. on Bonds	0	$+ibB_B, t-1$	0	0	0	$+ibB_{IF,t-1}$	0	0	0	$-ibB$	0
Dividends	$+Div$	$-Div_B$	0	0	0	0	0	$-Div_F$	0	0	0
Profits	0	$-\Pi_B$	$+\Pi_B$	0	0	$-\Pi_{IF}$	$+\Pi_{IF}$	$-\Pi_F$	$+\Pi_F$	0	0
Change in the stocks of											
Deposits	$-\Delta D_H$	0	$+\Delta D$	0	0	0	$-\Delta D_{IF}$	0	$-\Delta D_F$	0	0
Loans	$+\Delta L_H$	0	$-\Delta(1-z)L$	0	$-\Delta zL$	0	0	0	$+\Delta L_F$	0	0
Derivatives	0	0	0	0	$+\Delta ABS$	0	$-\Delta ABS$	0	0	0	0
Shares	$-\Delta Sh$	0	0	0	0	0	$+\Delta Sh$	0	0	0	0
Bonds	0	0	$-\Delta B_B$	0	0	0	$-\Delta B_{IF}$	0	0	$+\Delta B$	0
Δ Total	0	0	0	0	0	0	0	0	0	0	0

Table 2: Aggregate Transaction Flow Matrix

	Households	Banks	SPV	IF	Firms	Gov	Total
Own Funds	$+\Delta OF$	$-\Delta OF_B$			$-\Delta OF_F$		0

Table 3: Revaluation Matrix

3.1 List of events

In each simulation period, the timeline of the events is the following:

1. *Production: non-financial firms decide how much to produce adjusting previous period desired production in light of the gap between previous period demand and desired supply. Actual production is defined based on a Leontief production function. Employment is generated. Wages are set according to a Philips curve-type process and prices (hence inflation) according to mark-up pricing rule.*
2. *Income: (2.a) employed households receive wages, while those unemployed receive a dole from the government; (2.b) financial flows, among which interests payments, interest receivable and dividends out of previous period profits are paid.*
3. *Households set their desired level of consumption and financial assets' holdings (deposits and shares), hence defining their demand for credit.*
4. *Credit market: banks set the borrower-specific interest rates for individual households and for the non financial firms sector, and decide whether to fully accommodate households credit demand.*
5. *If credit is rationed, households revise their plans through a pecking order process. They first scale down demand (and holding) of shares; they then reduce deposits; they eventually cut consumption to a minimum subsistence level.*
6. *Public expenditure and investment take place: the government purchases goods from the non-financial firms sector which in turn purchases capital goods from itself.*
7. *The goods market: The goods market clears. Goods are assumed as perishable. In case of excess supply, excess production wipes out. In case of excess demand, the rationing is proportional to individual components of aggregate demand.*
8. *Government collects taxes and, if needed, issue bonds to finance public deficit.*
9. *Financial assets: Investment funds purchase ABSs and public bonds, the latter being bought also by commercial banks.*
10. *Commercial banks set the amount of retained earnings based on their capital needs.*

3.2 The equations

A complete list of equations can be found in the appendix. Here, we present key behavioural choices. The suffices i and t define individual households and the simulation period throughout all the model, respectively. Asterisks are used to identify all quantities whose original value may differ from what eventually set, as in case of desired or target levels.

3.2.1 Non-financial firms

Non financial firms is an aggregate sector that uses capital and labor to produce a single good used for both consumption and investment purposes according to a Leontief production function. For the sake of simplicity, we do not consider inventories. However, possible excess supply (with respect to aggregate demand) is taken into account by firms in the revision of their production plans and in the definition of profit margins over average total costs.

The first set of equations describing the behaviour of this sector concerns the choice of the production level, and with it, the level of employment. Firms decide how much to produce (Equation 1) updating previous period desired level of production according to two elements: an exogenous component of growth (υ_2), and the distance between previous period desired levels of supply ($Y^*_{S,t-1}$) and aggregate demand ($Y^*_{D,t-1}$). A production function à la Leontief determines the maximum level of production (Equation 4) according to available productive inputs and corresponding productivity. (K_{t-1}) is installed capital stock and ($\bar{N}$) is the total labor force. (X^K) and (X_t^L) stand for capital and labour productivity, respectively. Desired production will coincide with actual aggregate supply if it does not exceed maximum production capacity (5). While capital productivity is fixed, labor productivity increases through time. The growth rate of labor productivity depends positively on the exogenous parameter χ_1^L, and on the observed growth rate of aggregate demand. This latter component captures a Kaldor-Verdoorn type effect (Equation 6). Once set, the production level, divided by labor productivity (Equation 7), determines employment.

$$Y_S^* = \left[Y_{S,t-1}^* + \upsilon_1 \cdot (Y_{D,t-1}^* - Y_{S,t-1}^*)\right] \cdot (1 + \upsilon_2) \tag{1}$$

$$Y_K^{MAX} = K_{t-1} \cdot \bar{X}^K \tag{2}$$

$$Y_L^{MAX} = \bar{N} \cdot X_t^L \tag{3}$$

$$Y^{MAX} = min(Y_K^{MAX}, Y_L^{MAX}) \tag{4}$$

$$Y_S = \begin{cases} \text{if } Y_S^* \leq Y^{MAX} \Longrightarrow Y_S = Y_S^* \\ \text{if } Y_S^* > Y^{MAX} \Longrightarrow Y_S = Y^{MAX} \end{cases} \tag{5}$$

$$X_t^L = X_{t-1}^L \cdot \left[\chi_1^L + \chi_2^L \cdot \left(\frac{Y_{D,t}^*}{Y_{D,t-1}^*} - 1\right)\right] \tag{6}$$

$$N_t = \frac{Y_S}{X_t^L} \tag{7}$$

The second group of firms choices refers to prices and wages. Wage inflation, *i.e.* the rate of growth of the wage bill (see Equation 8), is first linked to observed previous period price inflation (π_{t-1}). This term is meant to capture trade unions' attempt to maintain workers purchasing power by tracking observed increase in prices at time *t-1*.The growth rate of nominal wages then depends negatively on the unemployment rate (un_t) according to a Phillips curve-type dynamics. Instead, it responds positively to increases in labor productivity. Equation (9) shows updates in the wage bill, which, next to wage inflation, also takes into account for change in the employment level.

Once defined labor costs, non-financial firms set prices by applying a mark-up (μ_t) over average total costs. These are given by total costs, which include both the wage bill (W_t) and financial payments ($r_{t-1}^f \cdot L_{t-1}$), over supply (Equation 10). (μ_t) moves endogenously (Equation 11) between an exogenous ceiling (μ_{MAX}) and a minimum acceptable value (μ_1) mark-up would asymptotically tend to in the (hypothetic) event of an infinitively large excess supply. The mark-up increases (decreases) with previous period excess demand (supply).

$$\omega_t = (\pi_{t-1}) \cdot \left[\frac{\omega_1}{(\omega_2 + un_t)} + \omega_3 \cdot \frac{X_t^L - X_{t-1}^L}{X_{t-1}^L}\right] \tag{8}$$

$$W_t = W_{t-1} \cdot \left[1 + \omega_t + (\frac{N_t}{N_{t-1}} - 1)\right] \tag{9}$$

$$p_t = (1 + \mu_t) \cdot \left[\frac{W_t + r_{t-1}^f \cdot L_{t-1}}{Y_S}\right] \tag{10}$$

$$\mu_t = max\left(\mu_{MAX}, \mu_1 + \mu_{t-1} \cdot \frac{Y_D^*}{Y_S}\right) \tag{11}$$

Finally, firms will take their investment decisions. The desired rate of growth of real capital stock (Equation 12) depends on three elements: a positive autonomous component (γ_1); previous period profit share; and the distance between the actual and the exogenous *normal* (u_N) level of capacity utilization. Firms finance their investment through retained profits, which are a fixed portion of net profit, and banks' loan (more on this in Section 3.2.4). Desired and realized investment may differ: whenever demand, given by the sum of the desired levels of consumption, investment, and public expenditure, exceeds supply, rationing takes place. Each component of aggregate demand, investment included, is reduced proportionally.

$$g_t^* = \gamma_1 + \gamma_2 \frac{\Pi_{t-1}}{Y_{t-1}} + \gamma_3 \cdot (u_{t-1} - u_N) \tag{12}$$

$$I_t^* = K_{t-1} \cdot g_t \tag{13}$$

$$K = K_{t-1} + I_t - \delta K_{t-1} \tag{14}$$

3.2.2 Households

The households sector is populated by $\bar{N}$ heterogeneous agents characterized by different levels of income, consumption, savings, wealth and indebtedness. Households' disposable income (Equation 15) consists of three entries. Households first receive a nominal wage $w_{i,t}$ if employed, or dole paid by the government in case they are unemployed. Financial income accrues to households in the form of (i) interest receivables from IFs' shares eventually held at the beginning of the period ($r^{sh} \cdot sh_{i,t}$); (ii) dividends ($div_{i,t}$) from banks and non-financial firms. For the sake of simplicity, we do not explicitly model the equity market. We assume households own non-financial firms and commercial banks in proportion of their wealth, and that dividends are distributed accordingly. Outlays are taxes on income ($tax^w_{i,t}$), and "effective" interest payment. The latter is given by individual interest rate ($r^h_{i,t-1}$) times previous period stock of debt (*i.e.* bank loan $Lh_{i,t-1}$). It is labelled effective" and signalled by the tilde in (Equation 15) as it is diminished by the part of due payments that households may not be able to meet.

$$yd_{i,t} = w_{i,t} - tax^w_{i,t} + r^{sh} \cdot sh_{i,t} + div^T_{i,t} - \widetilde{r^h_{i,t-1} \cdot lh_{i,t-1}} \tag{15}$$

In any period of time, the wage bill (see Section 3.2.1) is distributed among employed households following a log-normal distribution with log-standard deviation θ. Taxation is progressive. There are two tax rates, with the higher applied to the part of wage exceeding a threshold (median wage). The interest rates, the rate of return on shares, and the dividends will be discussed in details in the following sections. To meet their financial commitments, indebted households can use all their income, net of taxes, and their stock of deposits, with the exception of the small amount required for subsistence consumption, set as a portion of previous median consumption. For sake of simplicity, we assume loans to be perpetuities, which implies that households do not repay the principals. Defaults therefore result into *non-performing interest* (NPI). It is important to notice that part of the financial income obtained from shares depends on ABSs (more on this below), which convey interest payment from indebted households to those holding shares. Since households may be at the same time financial investors and borrowers, a problem of simultaneity arises. To solve this issue, we use a recursive process in which, first, debt is serviced without using income from shares. Then, once the first round of interest payment is collected and distributed, a second round of payments takes place from those, among shares' holders, who were initially unable to fully meet their financial commitments . The process goes on until the additional amount of interest paid is below a given threshold (10 percent of due interests).

Desired consumption is first computed by applying an uniform propensity to consume (c_y) out of total disposable income $yd_{i,t}$. Total disposable income, however, is reduced by a portion (es_f) of financial incomes. Consistent with the empirical findings by Onaran et al. (2011), as well as previous SFC models on inequality (see, for instance van Treeck, 2011; Detzer, 2018), this assumption captures different consumption (and hence saving) propensities out of wages and of financial income, the former being higher than the latter. The social component of desired consumption is finally given by a proportion (c_n) of previous period average consumption.

Two reasons may lead to the final level of consumption differing from what desired. First, commercial banks may ration credit (see more on this below). Second, just as it happens with investment, if excess aggregate demand is recorded in the economy. In such an event, each household will be forced to reduce her consumption by an amount proportional to her desired level.

$$c^*_{i,t} = c_y * [yd_{i,t} - es_f * (r^{sh} SH_{i,t} + div_{i,t})] + c_n \bar{c}_{t-1} \tag{16}$$

Once defined desired consumption (and savings), households then set their desired stock of financial assets. Desired deposits (Equation 17) are a fixed portion (η_H) of previous period individual wealth stock. The desired level of IFs shares is the result of an adaptive process: previous period individual stock of shares is adjusted according to the observed difference between the returns on the shares issued by investment funds ($rsh_{i,t-1}/Sh_{i,t-1}$) and on public bonds ($i^B_{i,t-1}$), which is taken as point of reference for evaluating the *relative* remurativeness of more speculative types of financial investments (i.e. IFs shares). The higher this spread in favor of one of the assets (normally shares), the higher the demand for such asset. Demand for loans (Equation 19) eventually results from the difference between the desired flows of financial assets and desired/planned saving (S^*), as given by disposable income minus desired consumption (Equation 19).

$$Dh^*_{i,t} = \eta_H \cdot Wh_{i,t-1} \tag{17}$$

$$Sh^*_{i,t} = Sh_{i,t-1}[1 + \sigma(\frac{rsh_{i,t-1}}{Sh_{i,t-1}} - i^B_{i,t-1})] \tag{18}$$

$$\Delta Lh^*_{i,t} = \Delta Dh^*_{i,t} + \Delta Sh^*_{i,t} - S^*_{i,t} \tag{19}$$

As mentioned above, whenever rationed, households revise their choices following a pecking order procedure. First, they reduce the expansion of shares and, then, deposits. If needed, financial assets' holding could also be diminished by, say, redeeming IFs shares. As last resort, households may reduce their consumption down to a minimum subsistence level (see Equation A.30 in the appendix for a more formalized representation of this point).

3.2.3 The government

The government purchases goods to offer public services, transfers a dole to unemployed households, collects taxes, and issues bonds to finance public deficit.

Public purchases (Equation 20) are modelled in the simplest way possible. They first revolve around their previous period's level (given hysteresis in government purchases) through parameter ξ in Equation (20). Then, they are linked positively to aggregate consumption through parameter ξ_2 to capture observed proportionality among demand injections in aggregate demand. As said, all unemployed households will receive a public dole (set as 75 percent of previous period lowest wage). This embodies the anti-cyclical component of public spending. The last source of outlays are interest paid on public debt stock.

Fiscal revenues arise from the collection of income taxes on income, commercial banks' and non-financial firms' profits ($\tau_3 \cdot \Pi_t$), as well as taxes (τ^{WH}_i) on households' wealth ($WH_{i,t}$)[9].

In case of fiscal deficit, the government issues public bonds, purchased by IFs and commercial banks. The interest rate on public bonds is defined through an adaptive and recursive rule (23). Starting from previous period level, it changes with the portion of debt purchased by commercial banks. Since commercial banks buy all the bonds not purchased by IFs, an increase in the share they hold proxies a lower demand for public securities and, as such, leads to a higher interest rate. Since a higher interest rate determines a higher demand by investment funds, a new round begins. The process comes to an end whenever the increase in interest rate, determined within a round, is below a threshold (ϕ)

$$G_t = \xi_1 \cdot G_{t-1} + (1 - \xi_1) \cdot \xi_2 \cdot C_t \tag{20}$$

$$T_t = \tau_3 \cdot \Pi_t + \sum_{i=1}^{N} \tau^w_i w_{i,t} + \sum_{i=1}^{N} \tau^{WH}_i WH_{i,t-1} \tag{21}$$

$$\Delta GD_t = G_t + dole \cdot \left[\bar{N} - N_t\right] + i^b_{t-1} \cdot GD_{t-1} - T_t \tag{22}$$

$$i^b_t = i^b_{t-1} \cdot [1 + \alpha(\frac{B_{B,t}}{GD_t} - \frac{B_{B,t-1}}{GD_{t-1}})] \tag{23}$$

[9]We assume the wealth tax to be collected automatically, at the beginning of each period, by deducing it from accumulated households deposits. As such, it does not contribute to determine disposable income, but may certainly influence consumption possibilities by affecting households' available liquid assets.

3.2.4 Banks

The aggregate banking sector is central in our model. On the one hand, through credit creation, it feeds both production and the purchases of consumption goods, investment goods, and financial assets. On the other hand, through lending, it supplies the inputs for the securitization process (Lysandrou, 2011; Adrian and Ashcraft, 2012; Caverzasi et al., 2019). Moreover, it buys all the public bonds that remain unsold on financial markets (*i.e.,* that are not purchased by investment funds).

The credit creation process is based on banks' assessment of potential borrowers' creditworthiness. As the process is largely analogous in case of households or non-financial firms, we will focus on the first and then we highlight the differences with respect to non-financial firms. First, banks will set the individual interest rate (Equation 24) as a mark-up on the observed base rate (i^T_{t-1}), exogenously set by the central bank. Through parameter (ι), the mark-up increases with the financial fragility of the borrower, which is proxied by the ratio between, on the one hand, the product between the observed based rate (i^T_{t-1}) and the new desired level of indebtedness - previous period stock ($Lh_{i,t-1}$) plus desired loan ($\Delta Lh^*_{i,t}$) - and, on the other hand, her net income ($yn_{i,t}$). In the case of non-financial firms, this computation is made in relation to firms' net profit (Pf_t) instead of households' net income.

$$E[r^h_{i,t}] = i^T_{t-1} + \iota_h i^T_{t-1} \frac{Lh_{i,t-1} + \Delta Lh^*_{i,t}}{yn_{i,t}} \tag{24}$$

$$E[r^f_t] = i^T_{t-1} + \iota_f i^T_{t-1} \frac{Lf_{t-1} + \Delta Lf^*_t}{Pf_t} \tag{25}$$

$$mh^*_{i,t} = E[r^h_{i,t}] \frac{Lh_{i,t-1} + \Delta Lh^*_{i,t}}{yn_{i,t}} \tag{26}$$

$$mf^*_{i,t} = E[r^f_{i,t}] \frac{Lf_{i,t-1} + \Delta Lf^*_{i,t}}{Pf_t} \tag{27}$$

The concession of the loan is conditional to the comparison between such *notional* debt-service ratios (see Equations 26 and 27) - *i.e.,* what the service ratio would be in case of the loan being granted - and the endogenous parameter Ψ_t, which represents commercial banks' acceptable level of borrower's debt burden. The value of Ψ_t is set within a corridor, whose floor and ceiling are parameters Ψ_{min} and Ψ_{max}, respectively. Within this corridor, the endogenous level of Ψ_t (see Equation 29) decreases with the ratio between unpaid interests over total interest payment. Instead, it increases with the degree of commercial banks' compliance with regulatory capital adequacy requirements. This is modeled as the distance between commercial banks' *actual* own capital-asset ratio ($k_{B,t}$, see Equation 30), i.e., a measure of commercial banks' leverage, and a Basel-type exogenous regulatory capital adequacy ratio ($\bar{k}$).[10] In Equation (30), commercial banks' actual capital-asset ratio is given by observed commercial banks' own funds (Ω^B_{t-1}) over their total on-balance sheet assets (see more on this below). The former element in Equation (29) captures the idea that, witnessing higher default rates, banks become more prudent and make lending standards more stringent. The second element, instead, suggests that the more leveraged the banking sector is, the more it will try to avoid risky loans. Other way around, when commercial banks are well within regulatory limits (i.e. $k_{B,t} > \bar{k}$), they are more prone to exploit the space of manoeuvre in their balance sheet to expand their business. Increasing (decreasing) values of (Ψ_t) thus stand for more relaxed (tighter) lending standards.

Commercial banks' total assets are given from the sum between banks' stock of public bonds ($B_{B,t}$) and the amount of outstanding loans net of the portion (z) moved to SPVs' balance sheet in the securitization process. In the present model, following Botta et al. (2021, 2022), and consistent with Lysandrou (2011) and Goda and Lysandrou (2014), we assume that commercial banks securitize loans in the amount needed to satisfy the demand of ABSs (see more on this below) by IFs via SPV. For this reason, (z) is an endogenous variable that adjusts "on demand", and that is equal to the fraction between demanded ABS and outstanding households' and non-financial firms' loans (see Equation 31). The demand for ABSs will be satisfied up to the point no more loans are available for securitization. Note that in Equation (30), the higher the amount of securitized loans, the better is commercial banks' capital-asset ratio. Commercial

[10] Basel-type exogenous regulatory capital adequacy ratio ($\bar{k}$) is set equal to 8 percent.

banks' may actually use securitization to actively manage their balance sheet and open more space for future rounds of loans' creation.

$$\Psi_t = max\left[\Psi_{min}, min(\Psi_{max}, \Psi^*)\right] \tag{28}$$

$$\Psi^* = \bar{\Psi}_{min} - \psi_1 * \frac{NPI}{(\sum_{i=1}^{N} r^h_{i,t-1} Lh_{i,t-1}) + r^f_{t-1} Lf_{t-1}]} + \psi_2 \cdot (k_{B,t} - \bar{k}) \tag{29}$$

$$k_{B,t} = \frac{\Omega^B_{t-1}}{[(1-z_t)L_t + B_{B,t}]} \tag{30}$$

$$z_t = \min(1, \frac{ABS^D_{IF}}{L_t}) \tag{31}$$

Once computed $mh^*_{i,t}$, $mf^*_{i,t}$, and Ψ_t, commercial banks will extend credit to households and firms whenever households' (firms') *notional* debt-service ratio falls lower than banks' "acceptability" threshold. Rationing takes place in the opposite case. In this regard, banks' choice with respect to the firms' demand for loans differs from that related to individual households in the fact that individual households' rationing applies to the whole amount of demanded new loans. Non-financial firms, instead, once rationed, will receive loans up to the point in which their debt service ratio equals Ψ_t. This choice is conceived to avoid extreme dynamics, as *on-off* decisions which are diluted amid a heterogenous sector may prove to be brutal if applied at the aggregate level.

At the end of each period, banks decide the share of net profit P^B_t (see Equation 32) to distribute and temporarily shelved as dividend payable (*i.e.,* dividends determined at time t are paid in the following period *t+1*). This choice is ultimately based on banks' financial conditions and on Basel-type regulation. First, banks compute (Equation 33) the level of own capital which, given their stock of assets, would meet the required capital adequacy ratio ($\bar{k}$). Second, they set the desired level of capital injection ($\Delta\Omega^*$) and, hence, retained profits, which is either a fixed share (ζ_B) of the distance between required and observed own capital, whenever needed (*i.e.* $k_{B,t} < \bar{k}$), or zero otherwise. This implies the attempt of banks to adjust their balance sheet to comply with regulation takes place in a progressive manner.

Finally, Equation 35 tells us that whenever net profits are higher than required capital injections, dividends payable result as residual after retained profits are detracted from banks' net profits (P^B_t) - see Equation (35). Otherwise net profits are fully retained (36) as banks' *actual* capital injection is lower than the required desired one (see Equation 36).

$$P^B_t = \Pi^B_t(1 - \tau_3) \tag{32}$$

$$\bar{\Omega}^B_t = \Big[(1-z)L_t + B_{B,t}\Big] \cdot \bar{k} \tag{33}$$

$$\Delta\Omega^*_t = \begin{cases} \text{if } k_{B,t} & < \bar{k} \Longrightarrow \Delta\Omega^*_t = \zeta_B \cdot (\bar{\Omega}^B_t - \Omega^B_{t-1}) \\ \text{if } k_{B,t} & \geq \bar{k} \Longrightarrow \Delta\Omega^*_t = 0 \end{cases} \tag{34}$$

$$\text{if } \Delta\Omega^*_t \leq P^B_t \Longrightarrow \begin{cases} \Omega t = \Omega_{t-1} + \Delta\Omega^*_t \\ div_B = P^B_t - \Delta\Omega^*_t \end{cases} \tag{35}$$

$$\text{if } \Delta\Omega^*_t > P^B_t \Longrightarrow \begin{cases} \Omega t = \Omega_{t-1} + P^B_t \\ div_B = 0 \end{cases} \tag{36}$$

3.2.5 Investment Funds

IFs represent financial markets' operators that collect funds, i.e., IFs shares (SH_t), that households want to invest in financial markets. As said, IFs are somehow households' access gate to financial markets and, possibly, financial speculation, i.e., the allocation of funds between different financial assets characterized by different returns. IFs first keep a portion (η_{IF}) of collected funds collected in the form of deposits (37), which pay no interests, for precautionary reasons. More specifically, this is done to meet possible demands for shares' redemption by households. The remaining is allocated between ABSs and public bonds according to changes in their relative returns. Equation 38 represents this allocation choice. The quota ($q^b_{if,t}$) assigned to the purchasing of public bonds is set through an adaptive rule, and decreases when the spread between the return on ABSs. i.e., (r^{abs}), and the interest obtained on public bonds (i^B) observed in the current period is higher than in the previous one. In other words, the higher the return on ABSs with respect to public bonds, the lower will be the demand for the latter. The positive parameter (β) modules the strength of the impact of the variation in the spread over this choice. Demand for public bonds (see Equation 39) is thus obtained multiplying this quota for the amount of funds collected by IFs and not held in the form of deposits ($SH_t(1-\eta_{IF})$). Demand for ABSs results as a residual (see Equation 40). Finally, Equation (41) shows that in case of excess demand for ABSs, ABSs held by IFs at the end of the period will adapt to supply, which, by construction, is given by securitised loans. In other words, IFs can purchase ABSs as far as there are securitised loans.

$$D_{IF,t} = \eta_{IF} \cdot SH_t \tag{37}$$

$$q^b_{if,t} = q^b_{if,t-1} \cdot \left\{1 - \beta[(r^{abs}_t - i^B_t) - (r^{abs}_{t-1} - i^B_{t-1})]\right\} \tag{38}$$

$$B^D_{IF,t} = q^b_{if,t} \cdot SH_t \cdot (1-\eta_{IF}) \tag{39}$$

$$ABS^{*D}_{IF,t} = SH_t \cdot (1-\eta_{IF}) - B_{IF,t} \tag{40}$$

$$ABS_{IF,t} = min(z_t L_t, ABS^{D*}_{IF,t}) \tag{41}$$

$$\tag{42}$$

4 Simulations

In this section we present the simulation results produced by running our AB-SFC macro model under different scenarios. The artificial economy we study is populated by $\bar{N} = 1000$ heterogeneous households and it is simulated for T = 250 periods of which only the last 50 are considered for the analysis we will present in what follows.[11] We first study the properties of the computational model by simulating it under different interest rates "environments" (see Section 4.1). We do so to highlight the main macroeconomic, financial and distributional features emerging under LIRE *vs.* GM. Then, we introduce an interest rate hike and analyze how it differently impacts on the macro-financial dynamics of the economy in these two different environments (see Section 4.2). Finally, we study how securitization affects the functioning of the economy and the effectiveness of monetary policy (see Section 4.3).

4.1 LIRE vs. GM

We perform 200 Monte Carlo simulations of the model, 100 for the LIRE and 100 for GM. The model is exactly the same in the two batteries of simulations except for the level of the policy rate. It is near to the ZLB, namely 0.5 percent[12], under LIRE, whereas it is equal to 4 percent in the GM scenario[13].

Table 4 includes some statistics about relevant macro-financial variables of the simulated model. We compute the averages of listed variables across multiple simulations. A t test on equal means has been performed to check for statistically relevant differences between the two scenarios. For all the variables on which the t test was applied, it rejects the null hypothesis that the population means are equal but for average real GDP growth rate. Nevertheless, the final level of real GDP is a bit different in the two scenarios. It is almost 95 percent lower during GM than under LIRE. Over a long time span, a slightly higher and, above all, more stable growth rate characterizing LIRE results in a higher final level of real GDP compared to the GM scenario.[14] Basically, the economy grows a bit faster under LIRE than GM.

[11] In other words, the first 200 periods of each simulation are discarded to get rid of transient dynamics tied to initial conditions. Initial conditions are such that all variables are set to zero but the few ones necessary to activate the economy.

[12] This is the average FED fund rate recorded, at monthly level, between October 2008, *i.e.*, straight after FED's abrupt cut in its policy rate at the heights of the 2007-2008 financial shock), and February 2022, that is when FED started the most recent surge in that same rate. See https://fred.stlouisfed.org/series/FEDFUNDS.

[13] This is approximately equal to the average FED fund rate (i.e. 4.37 percent) recorded between January 1991 to July 2007, i.e., just before the last financial crisis started to intensify and FED prompted a quick reduction in its policy rate. See https://fred.stlouisfed.org/series/FEDFUNDS.

[14] The additional explanation for the different performance is tied to the first periods of simulations, where LIRE outperforms GM. Then, the two scenarios evolve based on similar growth rates, with the LIRE one slightly higher than in GM,

The results for other variables are stronger. For instance, output volatility is remarkably higher during GM than LIRE. As expected, inflation is lower and unemployment higher during GM than LIRE. Low interest rates feed a growth regime featuring a bit higher growth rate and more employment with the consequence of stimulating faster price dynamics. The inflation rate emerging from LIRE may not be in line with central bank's objective though, and this may lead to policy rate's increases whenever the conditions for the LIRE no longer hold (for example, in a post-pandemic scenario)[15].

	LIRE	**GM**
real GDP at t=T	1	0.9493
avg real GDP growth rate	0.0032	0.0031
std real GDP growth rate	0.0006	0.0082
inflation rate	0.0688	0.0410
unemployment rate	0.0258	0.0723
public debt over GDP	0.0000	1.6567
total loan stock over GDP	1.2924	2.2533
interest rate on loans	0.0070	0.0524
unpaid interest over total interest	0.0001	0.0341
consumption inequality	0.1946	0.2832
income inequality	0.3065	0.3754
wealth inequality	0.6956	0.7028
Share of securitized loans	0.2809	0.6105
bank profit over total assets	0.0065	0.0448
CAR	0.0629	0.0805
HH credit rationing	0.0041	0.2261
financial distress indicator*	0.0000	0.0296

* frequency of unpaid interest above 5% of all interests

Table 4: Low Interest Rate Environment (LIRE) vs. Great Moderation (GM). Average values of main variables across 200 Monte Carlo simulations (100 for each scenario). A t test on equal means has been performed to check for statistical difference in the two scenarios: the test rejects the hypothesis that the population means are equal, but for the case of average real GDP growth rate.

Indebtedness is, in general, way lower under LIRE than under GM. Indeed, public sector, on average, does not accumulate public debt under LIRE. Public debt is more than 1.5 times the GDP during GM, instead. The "no public debt" result that emerges under LIRE must be interpreted as the *qualitative* outcome of the quite "extreme" features of such a scenario. From an economic point of view, LIRE induces higher tax revenues thanks to higher GDP. More importantly, lower unemployment records and, hence, unemployment subsidies, significantly reduce government outlays. By the same token, the extremely low interest rate that characterizes LIRE contributes to squeeze to very low values interest payments on temporary public debt that possibly emerges in some of the Monte Carlo simulations. From a simulation point of view, it is worth stressing that zero is also the initial level of the public debt-to-GDP ratio at the beginning of the simulation, and that LIRE holds for the entire time span of the simulation itself. In this sense, such result might somehow be consistent with the stabilization or even reduction in public debt stocks (as a share of GDP) observed in most advanced economies during LIRE.[16]

Private (households and non-financial firms) debt is not much higher than GDP under LIRE, whilst it is more than two times the GDP during GM. Evidently, higher interest rates on private debtors - more than 5 percent during GM and less than 1 percent during LIRE - is tied to higher indebtedness. Such perhaps surprising result is due to the fact that, during GM, households, in particular poor indebted ones, require more loans to "keep up with the Joneses", achieve desired consumption, and (at least partly) cover higher debt services. Such necessity is also due to higher unemployment characterizing GM. The opposite

so basically along a very similar trend.

[15]This will be the subject under scrutiny in the following subsection.

[16]See IMF World Economic Outlook data at https://www.imf.org/en/Publications/WEO.

happens under LIRE. Increased demand for ABSs and higher securitization that go hand-in-hand with higher interest rates (see more on this below) explain a big chunk of such apparent high rates/high debt paradox. More extensive securitization of existing loans enable commercial banks to concede more credit to more indebted households despite more vulnerable financial and economic conditions.

Inequality is sensibly higher during GM than in LIRE along all the three reported dimensions: consumption, income, and wealth inequality (as measured by the Gini index). This is is related to the generation and distribution of financial incomes among the different households, which is magnified by deeper securitization characterizing GM. In fact, the share of securitized loans is visibly higher during GM (more than 60 percent) than during LIRE (less than 30 percent). Higher interest rate on loans charged during GM increases the remunerativeness of ABSs (versus public bonds), and raises its demand alongside that for IFs' shares. Higher flows of interests paid on loans originated and then securitized by the banking sector raises the remuneration of "rentiers" at the expense of more indebted low-middle income households. Such finance-led regressive redistribution of income is exacerbated by larger banks' profits and dividends, the bulk of them accrues to wealthier households. In the end, higher interest rates seem to promote a more financialized and unequal economy, namely a rentier-friendly economy.[17]

Another relevant difference between the two scenarios regards banks' profitability and CAR management. Under LIRE, low interest rates reduce commercial banks' profits. This, in turn, creates difficulties to commercial banks' ability to manage their capital adequacy ratio and meet capital requirements. Consistent with the empirical financial literature about LIRE (Claessens et al. (2018), Gambacorta and Shin (2018); Brei et al. (2019)), the banking sector struggles to meet capital requirements when interest rates remain low for long. Banks' capital adequacy ratio matches target during the GM. High interest rates guarantee a high bank's profitability and, hence, an easier accumulation of own funds to keep bank's capital in line with banks' regulation. As sketched above, a corollary result of this fact is that, under the LIREs, commercial banks tend to reduce distributed dividends (out of lower profits) given their increased need for new capital injections keeping actual capital-asset ratio consistent with regulatory dispositions. During GM, a higher dividends-net profit ratio emerges, which, as said, tend to amplify income inequality.

Reduced commercial banks' compliance with capital adequacy requirements could impair banks' capability to extend loans to households and firms. Lower households' debt-service ratios and default rates (read less unpaid interests), push in the opposite direction. In the end, credit rationing is extremely low under LIRE, whilst it involves more than the 20 percent of households asking for bank loans during GM. This is clearly related to different macroeconomic performances, i.e., growth and employment (as commented above), emerging out of the two scenarios, but also to commercial banks' more intense "search for risk" (i.e. concession of credit to more fragile households paying relatively higher interest rates) characterizing LIRE (see Brei et al. (2019); ESRB (2021)).

The last row of Table 4 reports a financial distress indicator. This is computed as the frequency of periods (along the time span from t=201 to T=250 and across Monte Carlo simulations) during which the amount of unpaid interests on bank's loans is larger than 5 percent of due interests. Somehow, this is a measure of non-performing loans. Borrowers' financial distress is close to zero under LIRE, whereas it is almost 3 percent during GM, signaling increased (households') fragility when interest rates are high.

Overall, LIRE's implications in terms of financial stability (with respect to GM) are mixed. LIRE may well reduce banking sector's profitability and capability to comply with regulatory requirements, which may in turn affect their ability to lend. Also, it may push banks to more actively "search for higher

[17]Our findings are somehow consistent with Borio (2022), when he claims that expansionary monetary policies that increase employment and reduce volatility without causing "runaway" inflation, i.e., keep inflation in the order of one digit around 5 percent, tend to reduce inequality. These monetary policy-related macroeconomic "criteria" are actually close to the macro-financial performances observed under LIRE. In more general terms, they are also in line with quite consolidated empirical evidence about the virtuous relation between low interest rates and low inequality (see Bivens (2015)). Montecino and Epstein (2015) offer a partially different perspective. In their view, unconventional monetary policy in the form of Quantitative Easing (QE) and large asset purchases may have actually carried out mild dis-equalizing effects in the post-GFC period by giving rise to asset bubbles, equity bubbles first and foremost. This fact notwithstanding, they still maintain the positive effects that conventional expansionary monetary policies may bring about as to the reduction of inequality, even when bringing the policy rate close to the ZLB. It is beyond the scope of this paper to analyze any possible impact of QE over inequality via financial assets' inflation. Yet, it may help to put some light on an additional way through which expansionary monetary policy may eventually reduce inequality by dampening different types of asset bubbles (with respect to equity): those related to the proliferations of securitization and ABSs

risks" by conceding loans to relative poor households usually excluded from formal credit circuits. At the same time, however, it reduces the general level of households' indebtedness, lowers their debt-service ratio, and improves their financial soundness. On top of this, reported and commented macroeconomic and distributional indicators point to LIRE as a scenario with a slightly higher growth rate, more employment and less inequality than GM. In a way, higher but perhaps more controllable (by regulators and supervisors) vulnerabilities concentrated in the banking sector may be more than compensated by lower *systemic* financial fragility. The inflation rate, however, is sensibly higher during LIRE than GM. This might not be consistent with central bank's inflation target and may induce it to quickly leave LIRE. In the next section, we analyze the consequences of an interest rate hike motivated by the central bank's will to slow down price dynamics.[18]

4.2 Interest rate hike: LIRE vs. GM

In the computational experiment we describe in this section, we assume that the central bank aims at reducing inflation by raising its policy rate. We will analyze a sequence of interest rate increases in the following section. Here, instead, we consider a single permanent positive shock to the policy rate. We perform 200 Monte Carlo simulations, 100 with an initial policy rate equal to 0.5 percent (LIRE), and 100 with an initial policy rate equal to 4 percent (GM). We introduce a +75*bps* increase in the policy rate from t=210 on in both scenarios. Figure 1 shows the results of this computational experiment. In each panel, we report all the multiple simulations we performed in the two scenarios taken into account. LIRE simulations are colored in red, whereas GM in blue. We can visually compare them holding in mind the general statistics commented in the previous section.

The monetary policy shock gives rise to an increase in the inflation rate in both cases in the *very* short run (see top-left panel in Figure 1). This is due to the increase in firms' financial costs, which are transmitted to prices and, hence, inflation, via mark-up pricing over total average costs. Given the contractionary effect of the interest rate hike over capacity utilization and employment, inflation then suddenly decreases. Not surprisingly given the different *relative* weight of this shock in the two different environments, inflation bounces back to pre-shock level in the GM case in the long run. Instead, it sets at a permanently lower level when central bank decides to leave LIRE.

Contractionary monetary policy shock induces unemployment to rise (see top-central panel in Figure 1). Such an increase is initially steeper and more pronounced during GM than under LIRE. Over time, however, unemployment tends to converge back to almost the same initial value in the former case, whilst it stabilizes around a new higher level when monetary contraction is undertaken in the latter. Such partially different long-term behavior of unemployment is tied to the evolution of real GDP (see top-right panel in Figure 1). Indeed, the initial surge in unemployment is caused by short/medium-run recessions in both scenarios, the downturn being relatively more intense during GM than LIRE. In the long term, however, post-shock permanently higher unemployment during LIRE seems to be associated with a long-lasting deceleration in real GDP growth. It is less so in the case of the Great Moderation. Monetary policy shock also brings visible effects over capacity utilization (central-left panel in Figure 1), which decreases in the short term, more so during GM than in LIRE. Over a longer time horizon, capacity utilization tends to go back to its initial level in both cases. After the initial reduction, firms adjust their production target and cut capital investment, given observed lower real GDP, in order to restore the desired rate of capacity utilization.

Debt levels, both public and private ones, which are already higher in the GM than during LIRE, rise in both scenarios. In the case of LIRE, the increase in public debt (see central panel in Figure 1) is mostly motivated by the rise in unemployment and, hence, unemployment benefits. It is mainly triggered off by the higher interest rate and, therefore, borrowing costs in the case of Great Moderation.

The increase in households' debt is more evident under LIRE (see central-right panel in Figure 1). During GM, the most relevant effect is larger volatility in households' debt, instead. The policy rate shock obviously influences private sector's financial soundness, households' one first and foremost (see

[18]Though we mention that a "high" inflation rate could not be in line with central bank's objectives, we do not believe that the central bank is the only actor that can intervene to control price dynamics. It is beyond the scope of this paper a detailed analysis of such institutional aspects. Nonetheless, we will briefly come back to this point in the conclusions and possible policy implications of this work.

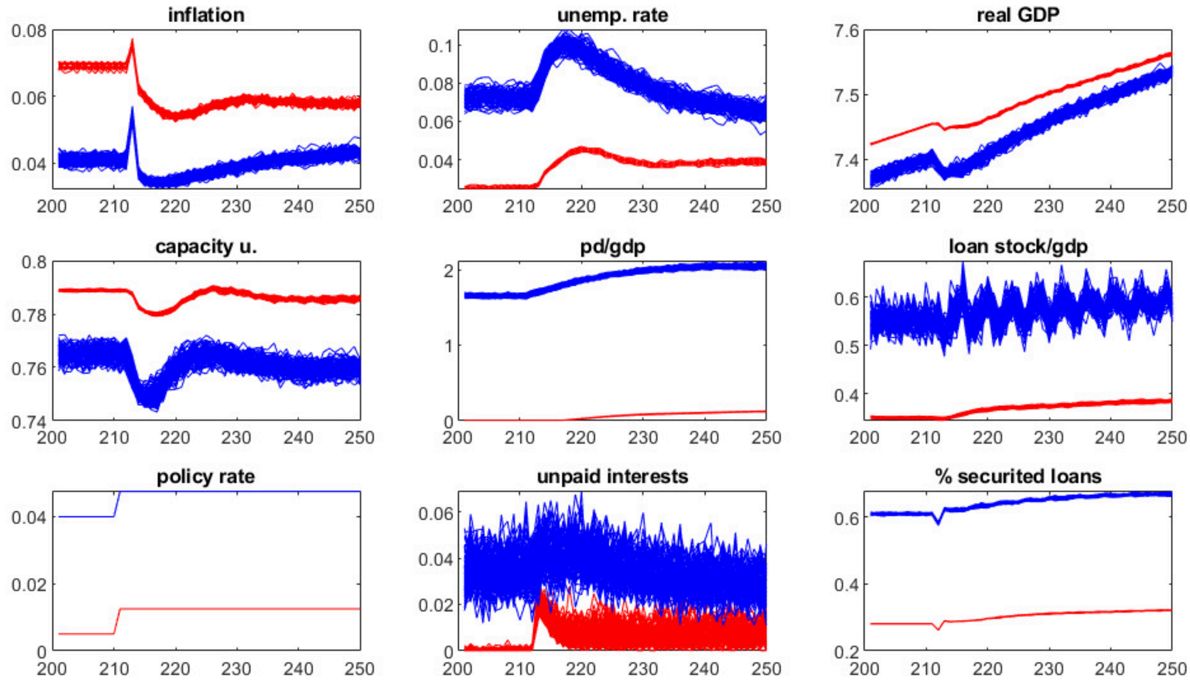

Figure 1: 75*bps* permanent policy interest rate increase at t = 210, LIRE (red) vs. GM (blue), 100 MC simulations per scenario.

central-bottom panel in Figure 1). In the short run, the amount of unpaid interests and, therefore, non-performing loans, rise in both cases. Such an increase, however, is far more substantial and sharper under LIRE than GM. This finding is consistent with the concave non-linear evolution in banks' provisions for distressed loans documented by Borio et al. (2017). Indeed, the (positive) sensitivity of this type of (banks') losses to the interest rate is stronger when the policy rate rises starting from very low values than from GM-like levels. Unpaid interests tend to overshoot over the long run. After the initial increase, non-performing loans mostly return to pre-shock levels during GM. In the case of LIRE, the initial steep rise is partially compensated by a subsequent decline. Both the level and volatility of such indicator of financial distress will remain higher than what recorded before the shock though.

Once again, the spread of securitization (see bottom-right panel in Figure 1) plays a big role in explaining the apparent paradox between more financially fragile yet more indebted households. The policy rate shock tends to make ABSs more remunerative, hence stimulating their demand alongside that one for IFs' shares. The diffusion of securitization practices is first meant to provide SPVs with the "raw material" (i.e. securitized loans) for the production of such complex financial products. At the same time, it also makes commercial banks' balance sheet more "flexible" and opens space for new rounds of credit creation. Commercial banks are ready (and eager) to accommodate households' applications for new loans despite increasing levels of indebtedness and clearer signs of financial fragility.

All in all, central bank's decision to increase its policy rate seems to be of particular relevance in the case of LIRE more than during GM. Effects are highly non-linear. And it is under LIRE that such contractionary monetary policy tends to produce a long-lasting slowdown in real GDP growth and a permanent increase in unemployment. These facts, which mainly hit low-middle income classes, together with the expansion of finance through securitization, jointly contribute to create a more unequal environment.[19] Once in a LIRE, leaving it may become a very hard and hazardous policy choice from the point of view of real-side, financial and distributional variables alike.

[19]In relative terms, that is considering that the level of inequality is in general higher in GM than LIRE, as discussed in the previous section.

4.3 Securitization and monetary policy

Innovation and sophistication in the financial industry, here captured by the presence of securitization and production of ABSs, lay behind some of the simulation results described in the previous parts of the paper. In this section, we perform two computational experiments that aim at disentangling and clarifying the role of securitization when monetary policy turns contractionary. More specifically, we now assume a series of interest rate's increases that are sequentially introduced since $t = 210$ on starting from a LIRE environment with the policy rate close to the ZLB and equal to 0.5 percent. This initial situation could be thought as the economy at the end of a pandemic. Repeated increases in the policy rate could be motivated by central bank's decision and will to better pursue its inflation goal and bring inflation closer to target. We assume the policy rate reaches 4 percent in seven steps, $50bps$ each (see top-left panel in Figure 2). Figure 2 reports the results of this experiment.

In general, contractionary monetary policy reaches its objective of reducing the inflation rate, which remains at lower levels when the policy rate stabilizes at 4 percent (see top-central panel in Figure 2). Disinflation is obtained through a large recession (see top-right and central-left panels in Figure 2) and a persistent increase in the unemployment rate (see central panel in Figure 2), as well as reduced financial solidity (more on this below). The increase in unemployment brought about by contractionary monetary policy also requires substantially more public spending (e.g., unemployment benefits) resulting in a strong increase of the public debt stock-to-GDP ratio (see central-right panel in Figure 2).

We are particularly interested in the different effect brought about by contractionary monetary policy due to the presence of securitization and production of ABSs. For this reason, we perform two batteries of multiple simulations, one with securitization and the other without it. In Figure 2, the 100 Monte Carlo simulations referred to the scenario featuring securitization are represented in red, whereas simulations without securitization are in blue. The presence of securitization does not play a big role insofar as the interest rate remains close to the ZLB. In a way, before $t = 210$, there are no differences between the two scenarios, and LIRE tends to neutralize the possible effects of securitization over macro-financial dynamics. The economic system reacts quite differently to the same sequence of interest rate increases though depending on the presence of securitization or not. Despite the above-mentioned (somehow expected) common trends and features (i.e. lower inflation, higher unemployment, short/medium-term economic downturn), the presence of securitization avoids a larger recession and ends up with a lower unemployment rate with respect to the case in which securitization is not allowed.

Households' debt increases substantially in the securitization case, whilst it is almost stable in the other case (see bottom-left panel in Figure 2). This is the essence of securitization process itself. Indeed, increasing interest rates incentivizes the financial system to securitize an increasing fraction of loans created by the commercial banks, thus leaving more space for commercial banks to create new loans while still meeting their capital adequacy requirements. It is precisely such larger availability of credit to the private sector, and the emergence of a (private) debt-led economy, that allows for a better overall macroeconomic performance of the system featuring securitization compared to the case without securitization. Rising policy rates also cause a significant increase in non-performing loans that is evident in both scenarios. Such increase is slightly higher in the "no securitization" case though. On the one hand, this result is linked to the positive effects that securitization seems to bring about faster economic growth and lower unemployment, hence households' capability to better deal with payment commitments on their accumulated debt burden. On the other hand, this is due to securitization, and the connected larger credit availability, enabling households to embark in speculative practices whereby new loans are used to meet interest payments on the old ones.

Given the results discussed above, one might claim that securitization and, more broadly, financial innovations connected to it, may improve the well functioning of the economy or, at least, avoid stronger monetary tightening-led recessions. Despite this view may find some empirical support[20], yet it must be taken with caution. First, possible positive effects of securitization over long-term trends come along with higher volatility and more pronounced cycles in some potentially crucial financial variables such as the amount of loans provided to the households' sector (as a share of GDP) - see bottom-left panel in

[20] Jorda et al. (2017), for instance, provide empirical evidence about the fact that more financialized economies, i.e., economies featuring higher levels of households' leverage, grow faster, are less volatile but are more exposed to tail shocks.

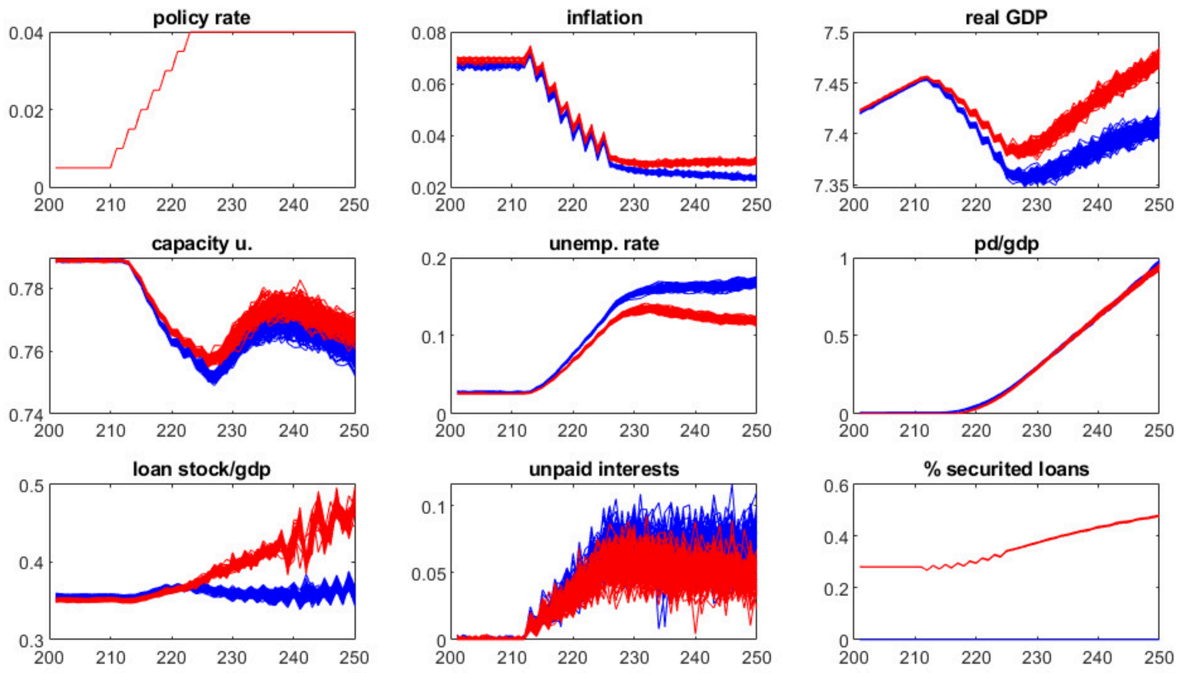

Figure 2: Sequence of 50*bps* policy rate increases from 0.5% to 4%, securitization (red) vs no securitization (blue), 100 MC simulations per scenario.

Figure 2. Consistent with Jorda et al. (2017), this might in turn expose the economy to more severe *finance-led* tail events[21]. Second, the presence of securitization fundamentally modifies the functioning of the economy as to price dynamics and the effectiveness of monetary policy itself in its capability to control inflation, possibly forcing monetary authorities to undertake harsher monetary restrictions.

Indeed, higher unemployment records in the "no securitization" scenario are associated with lower inflation rate with respect to what registered when securitization is allowed. To be fair, the interest rate's hike reduces inflation in both cases, but this is much less so when securitization is present. Other way around, the decrease in inflation as prompted by contractionary monetary policy is *weaker* in the securitization scenario than in the other case. In a way, securitization seems to make monetary policy relatively ineffective when it increases interest rates in the hope of curtailing inflation.

Given such evidence, here we study how strong does monetary contraction has to be to reduce and stabilize the inflation rate on the same level in the two scenarios considered so far. In order to do so, we perform a slightly different computational experiment in which we introduce a simple monetary rule guiding central bank's steering of the policy rate. Starting from LIRE featuring, on average, inflation rate equal to 6.76 percent, the central bank aims at reducing the inflation rate below 4 percent.[22] The results are displayed in Figures 3 and 4.

In Figure 3, we portray the evolution of inflation as caused by monetary policy tightening. In particular, we plot average inflation rates emerging in the two scenarios with the corresponding confidence intervals in both cases.[23] The final level of average inflation is within the confidence intervals built for both scenarios. The two average inflation rates are thus "statistically" equal to each other across the two different cases. Nonetheless, central bank has to raise its policy rate more substantially when secu-

[21] In the present model, the likelihood of such "extreme" events is significantly reduced, by construction, by the presence of macro-aggregated commercial banks' and non-financial firms' sectors that do not go bankruptcy, and by the assumption of partial rationing to non-financial firms.

[22] More precisely, we assume central bank's goal is an inflation rate below 4 percent and above 3 percent. The central bank checks the level of inflation every two simulation periods and changes the policy rate according to the explained monetary rule.

[23] The confidence intervals are given by the average ± two standard deviations.

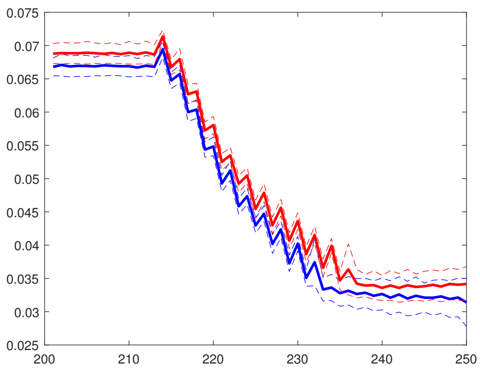

Figure 3: Inflation rate dynamics as the policy rate increases, 100 Monte Carlo simulations for each scenario – securitization (red) vs. no securitization (blue): average inflation rate and confidence intervals.

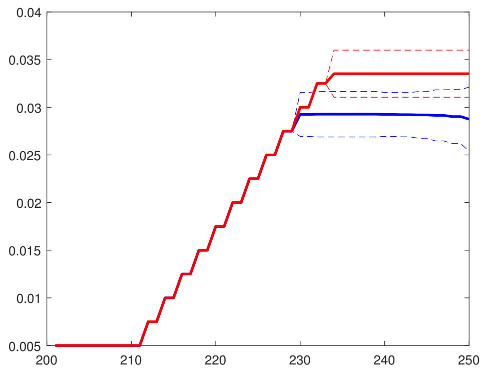

Figure 4: Policy rate hikes needed to reduce inflation below 4% (and above 3%), 100 Monte Carlo simulations for each scenario – securitization (red) vs. no securitization (blue): average policy rate and confidence intervals.

ritization is present than when it is not in order to reach this result. The presence (and the scale of) securitization influences the effectiveness of monetary policy. According to our computational experiments, the same disinflationary process needs a stronger monetary policy tightening when securitization is allowed with respect to the case in which such financial practice is not allowed (see Figure 4). As a consequence of this, the above-mentioned evidence about alleged pro-growth virtues of securitization are very much disputable given the apparent intrinsic contradiction between more developed financialized financial systems and the effectiveness of monetary policy. In a political-economic institutional setting in which monetary policy in demanded to solely pursue its inflation rate target, securitization may actually force monetary authorities to undertake, on average, more restrictive monetary policy stances than what would have been in the absence of securitization. But this might eventually imply macroeconomic dynamics to slow down rather than getting momentum, and finance-led potential instability to raise rather than to decline.

5 Conclusions

The protracted period of extremely low (close to the ZLB or even negative) interest rates following the 2007-2008 financial shocks has induced economists to investigate the macroeconomic implications of a Low(-for-long) Interest Rate Environment (LIRE). Most studies have concentrated on the financial sector only by looking at LIRE's effects over the behavior of financial actors (i.e. commercial banks and institutional investors) and the dynamics of some relevant financial variables (i.e. banks' profit, the capital adequacy ratio, the propensity to risk) - Borio et al. (2017); Claessens et al. (2018); BIS (2018); Brei et al. (2019); ESRB (2016, 2021), for instance. More recently, Grimm et al. (2023) have analyzed the relation between ultra-low interest rates and the build-up of financial bubbles, *joint* credit-housing bubbles in particular.

In this paper, we enlarge that perspective by considering the wider effects of LIRE, and of leaving it, through a broad macroeconomic framework. We put emphasis on the *interaction* between financial, real and distributional macro variables, as their dynamics are likely to co-evolve endogenously and feed back into each other (see Kumhof et al., 2015; Rajan, 2010, for instance). It is particularly so in the context of modern financialized economies, in which the spread of securitization and of complex financial products (ABSs) link together income and wealth distribution, and financial trends (see Botta et al., 2021, 2022). For this purpose, we develop a hybrid ABM-SFC model that captures the complex interaction between the different dimensions of the economy. The computational analysis carried out in this paper brings to three main results.

First, we confirm that LIRE, at least in comparison with a more "conventional" *Great Moderation*

(GM)-type scenario, may be source of some fragilities in the finance industry. It tends to reduce commercial banks' profitability - hence making capital adequacy requirements harder to meet - and incentivize higher "search for risk", namely credit's extension to more fragile households (see Borio et al., 2017; Claessens et al., 2018; Brei et al., 2019, among others). However, this takes place in the context of a possibly *more solid* macro system featuring lower unemployment, better income and wealth distribution, lower levels of (households') indebtedness and improved debt-service ratios together with lower levels of securitization and production of complex (and opaque) ABSs. As such, policy makers and regulators should pay attention to a possible *trade-off* between finance sector-specific risks and broader systemic risk when discussing the pro and cons of LIRE.

Second, as expected, LIRE is associated with faster price dynamics with respect to what observed in the GM-type scenario. Central banks may respond to this fact by leaving LIRE and (substantially) increasing interest rates. The response of the economy is highly *non linear* to whether interest rates' increases take place under LIRE or during GM. Narrower (wider) short-run downturns in real-sector variables (namely, real GDP, capacity utilization, and unemployment rate) observed under LIRE (GM) are however matched with permanent losses and signs of long-term economic slowdown with respect to the pre-shock environment. In the long term, the real side of the economy seems to be more resilient to the interest rate shock when this is engineered during the GM. In such a scenario, after a while, real side variables tend to return to pre-shock levels. In the financial side of the economy, interest rates' increases come along with a short-term spike in households' financial distress (i.e. the amount of non-performing loans) and a permanent increase in households' indebtedness when monetary tightening is implemented under LIRE. Such effects are less pronounced in a GM-type setting, even though banks' credit to households get far more volatile. Given such complex picture, policy makers might have to think twice about whether, when and how to leave LIRE once the economy has ended up into it, for whatever reason you want.

Third, securitization and the financial innovations connected to it, namely the production of complex financial products (i.e. ABSs), fundamentally alter the functioning of the economy. On average, securitization tends to stimulate higher and more stable growth in comparison to a system without securitization (see Jorda et al., 2017). However, it does so by prompting a debt-led economy, which also features higher cycles and volatility in credit's provision to households and it is possibly more exposed to finance-led tail risks. In this regard, we also put light on the *controversial* relation that exists between securitization and interest rates' increases. On the one hand, securitization (and the financial variables connected to it - see households' debt) get momentum when central bank raises interest rates. On the other hand, however, securitization tends to "neutralize" the expected (and searched) effects of the rise in interest rates over inflation (due to the stimulating effects that the very same spread of securitization may have on the economy). In a way, securitization may structurally undermine monetary policy's capability of controlling inflation, and may force monetary authorities to permanently adopt more restrictive monetary stances. Ultimately, such more restrictive monetary stances may well curb inflation but at the cost of slower growth and of a more unequal rentier-friendly economy.

Taken together, these results may bring back to the forefront the long-standing theoretical discussion about the role, goals and conduction of monetary policy. In the last four decades, monetary policy has been given a very active role as main, if not exclusive, policy tool for stabilizing business cycles. More than this, monetary policy alone has been given the sole or primary goal of controlling inflation. This paper seems to question such institutional framework. It may rather suggest to consider an alternative "*park-in*" monetary regime that shares the task of controlling inflation with fiscal and income policies (see Rochon and Setterfield, 2007). In such a regime, monetary authorities purse a low and stable interest rate in order to take in due account the distributional consequences of such variable. On the one hand, our simulations show that LIRE *without securitization* could equally achieve the same virtuous real-side effects of securitization reducing, at the same time, inequality and credit volatility. On the other hand, this could cause inflation to rise above target. The control of inflation should thus become joint responsibility of fiscal, income (read redistributive) and also, but not alone, monetary policy.

Our model presents several limitations, hence areas for further improvements. For instance, the present model does not include a housing sector. As such, it does not formalize the possible, but yet debated and controversial, role of LIRE feeding credit/housing bubbles (albeit admitting for ABS-related financial ones). Also, the simplifying assumption of aggregated banking and productive sectors, and the ensuing exclusion of banks' and non-financial firms' bankruptcies, tend to reduce systemic instability possibly deriving by volatile financial variables. We plan to include such additional features of an even more realistic (but far more complex) financial-real sector interaction in future research.

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Appendix A: Parameters

Symbol	*Description*	*Baseline*
θ	Log-standard deviation (wage distribution)	0.5
c_y	Propensity to consume out of income	0.65
c_y	Propensity to consume out of income	0.65
c_n	'Socially determined' consumption	0.3
ef	'excess saving' propensity on financial income	0.4
η_H	Households precautionary deposits	0.2
ζ_B	Tax rate on banks' profit	0.1
σ	Sensitivity to return on share/base rate spread (household portfolio choice)	1
ι_h	Sensitivity to the debt service ratio (HH interest rate setting)	0.3
ι_f	Sensitivity to the debt service ratio (Firms interest rate setting)	0.1
Ψ_{min}	Lower limit, threshold for debt service ratio	0.05
Ψ_{max}	Upper limit, threshold for debt service ratio	1/3
ψ_1	Sensitivity to NPI (threshold for debt service ratio)	0.1
ψ_2	Sensitivity to distance from regulatory limits (threshold for debt service ratio)	0.1
τ_1	Tax rate on banks' profit	0.2
τ_2	Tax rate on banks' profit	0.4
τ_3	Tax rate on profit	0.3
$\bar{k}$	Regulatory limit for leverage	0.08
υ_1	Excess supply or demand determined Exp production growth	0.5
υ_2	Exp production autonomous growth	0.05
χ_1^L	Productivity autonomous growth	0.003
χ_2^L	Demand led productivity growth	0.05
μ_1	Autonomous mark-up on costs (price determination)	0.15
μ_{MAX}	Ceiling mark-up on costs (price determination)	0.3
ω_1	Wage inflation sensitivity to unemployment (numerator)	0.005
ω_2	Wage inflation sensitivity to unemployment (denominator)	0.05
ω_3	Wage inflation sensitivity to labor productivty	0.05
γ_1	Autonomous component desired capital growth	0.1
γ_2	Sensitivity to profit share, capital growth	0.1
γ_3	Sensitivity to capcaity utilization share, capital growth	0.3
δ	Capital depreciation rate	0.1
ξ	Sensitivity to consumption (public purchases)	0.6
α	Tolerance in public bonds' interest rate setting	0.01
$\eta_I F$	Investment funds precautionary deposits	0.2

Table 5: Parameters

Appendix B: Equations

Firms

$$X_t^L = X_{t-1}^L * \Big[\chi_1^L + \chi_2^L * \Big(\frac{Y_{D,t}^*}{Y_{D,t-1}^*} - 1\Big)\Big] \tag{A.1}$$

$$Y_D^* = \frac{(C_t^* + p_t * I^* + G^*)}{p_t} \tag{A.2}$$

$$X^K = \bar{X}^K \tag{A.3}$$

$$Y_S^* = \big[Y_{S,t-1}^* + \upsilon_1 * (Y_{D,t-1}^* - Y_{S,t-1}^*)\big] * (1 + \upsilon_2) \tag{A.4}$$

$$Y_K^{MAX} = K_{t-1} * X^K \tag{A.5}$$

$$Y_L^{MAX} = \bar{N} * X_t^L \tag{A.6}$$

$$Y^{MAX} = min(Y_K^{MAX}, Y_L^{MAX}) \tag{A.7}$$

$$Y_S = \begin{cases} \text{if } Y_S^* & \leq Y^{MAX} \Longrightarrow Y_S = Y_S^* \\ \text{if } Y_S^* & > Y^{MAX} \Longrightarrow Y_S = Y^{MAX} \end{cases} \tag{A.8}$$

$$N_t = \frac{Y_S}{X_t^L} \tag{A.9}$$

$$u_t = \frac{Y_S}{X^K K_{t-1}} \tag{A.10}$$

$$Un_t = \bar{N} - N_t \tag{A.11}$$

$$un_t = \frac{Un_t}{\bar{N}} \tag{A.12}$$

$$\omega_t = \left[\frac{\omega_1}{(\omega_2 + un_t)} + \omega_3 * \frac{X_t^L - X_{t-1}^L}{X_{t-1}^L}\right] * (1 * \pi_{t-1}) \tag{A.13}$$

$$W_t = W_{t-1} * \left[1 + \omega_t + (\frac{N_t}{N_{t-1}} - 1)\right] \tag{A.14}$$

$$g_t^* = \gamma_1 + \gamma_2 \frac{\Pi_{t-1}}{Y_{t-1}} + \gamma_3(u_{t-1} - u_N) \tag{A.15}$$

$$I_t^* = K_{t-1} * g_t \tag{A.16}$$

$$K = K_{t-1} + I_t - \delta K_{t-1} \tag{A.17}$$

$$\mu_t = max(\mu_{MAX}, \mu_1 + \mu_{t-1} * \frac{Y_D^*}{Y_S}) \tag{A.18}$$

$$p_t = \frac{W_t + r_{t-1}^f * L_{t-1}}{Y_S} * (1 + \mu_t) \tag{A.19}$$

Households

$$yd_{i,t} = w_{i,t} - tax^w_{i,t} + r^{sh} * sh_{i,t} + div^T_{i,t} - \widetilde{r^h_{i,t-1} * lh_{i,t-1}} \tag{A.20}$$

$$tax^w_{i,t} = \tau^w_j w_{i,t} \begin{cases} \text{if } w_{i,t} < \hat{w}_t & \Longrightarrow tax^w = \tau^w_1 * w_{i,t} \\ \text{if } w_{i,t} \geq \hat{w}_t & \Longrightarrow tax^w = \tau^w_1 * \hat{w} + \tau^w_2 * (w_{i,t} - \hat{w}_t) \end{cases} \tag{A.21}$$

$$c^*_{i,t} = c_y * [yd_{i,t} - es_f * (r^{sh} SH_{i,t} + div_{i,t})] + c_n \bar{c}_{t-1} \tag{A.22}$$

$$s^*_{i,t} = yd_{i,t} - c^*_{i,t} \tag{A.23}$$

$$Dh^*_{i,t} = \eta_H WH_{i,t-1} \tag{A.24}$$

$$\Delta Dh^*_{i,t} = Dh^* - Dh_{i,t-1} \tag{A.25}$$

$$Sh^*_{i,t} = Sh_{i,t-1}[1 + \sigma(\frac{rsh_{i,t-1}}{Sh_{i,t-1}} - i^B_{i,t-1})] \tag{A.26}$$

$$\Delta Sh^*_{i,t} = Sh^*_{i,t} - Sh_{i,t-1} \tag{A.27}$$

$$\Delta Lh^*_{i,t} = \Delta Dh^*_{i,t} + \Delta Sh^*_{i,t} - s^*_{i,t} \tag{A.28}$$

$$\text{if } m^*_{i,t} < \Psi_t \Longrightarrow \begin{cases} \Delta Lh_{i,t} = & \Delta Lh^*_{i,t} \\ \Delta Sh_{i,t} = & \Delta Sh^*_{i,t} \\ \Delta Dh_{i,t} = & \Delta Dh^*_{i,t} \\ c_{i,t} = & c^*_{i,t} \end{cases} \tag{A.29}$$

$$\text{if } m^*_{i,t} > \Psi_t \Rightarrow Lh_{i,t} = 0 \Rightarrow \begin{cases} \text{if } s^*_{i,t} > \Delta Dh^*_{i,t} \Rightarrow \begin{cases} \Delta Sh_{i,t} > 0 \\ \Delta Sh_{i,t} = s^*_{i,t} - \Delta Dh^*_{i,t} \\ \Delta Dh_{i,t} = \Delta Dh^*_{i,t} \\ c_{i,t} = c^*_{i,t} \end{cases} \\ \text{if } s^*_{i,t} < \Delta Dh^*_{i,t} \text{ and } s^*_{i,t} + Sh_{i,t-1} > \Delta Dh^*_{i,t} \Rightarrow \begin{cases} \Delta Sh_{i,t} < 0 \\ \Delta Sh_{i,t} = s^*_{i,t} - \Delta Dh^*_{i,t} \\ \Delta Dh_{i,t} = \Delta Dh^*_{i,t} \\ c_{i,t} = c^*_{i,t} \end{cases} \\ \text{if } s^*_{i,t} + Sh_{i,t-1} < \Delta Dh^*_{i,t} \text{ and } s^*_{i,t} + Sh_{i,t-1} > 0 \Rightarrow \begin{cases} Sh_{i,t} = 0 \\ \Delta Sh_{i,t} = -Sh_{i,t-1} \\ \Delta Dh_{i,t} > 0 \\ \Delta Dh_{i,t} = s^*_{i,t} + Sh_{i,t-1} \\ c_{i,t} = c^*_{i,t} \end{cases} \\ \text{if } s^*_{i,t} + Sh_{i,t-1} < 0 \text{ and } s^*_{i,t} + Sh_{i,t-1} + Dh_{i,t-1} > 0 \Rightarrow \begin{cases} Sh_{i,t} = 0 \\ \Delta Sh_{i,t} = -Sh_{i,t-1} \\ \Delta Dh_{i,t} < 0 \\ \Delta Dh_{i,t} = s^*_{i,t} + Sh_{i,t-1} \\ c_{i,t} = c^*_{i,t} \end{cases} \\ \text{if } s^*_{i,t} + Sh_{i,t-1} + Dh_{i,t-1} < 0 \Rightarrow \begin{cases} Sh_{i,t} = 0 \\ \Delta Sh_{i,t} = -Sh_{i,t-1} \\ Dh_{i,t} = 0 \\ \Delta Dh_{i,t} = -Dh_{i,t-1} \\ c_{i,t} \geq \tilde{c} \\ c_{i,t} = yd_{i,t} + Sh_{i,t-1} + Dh_{i,t-1} \end{cases} \end{cases} \tag{A.30}$$

Government

$$G_t = \xi_1 \cdot G_{t-1} + (1-\xi_1) \cdot \xi_2 \cdot C_t \tag{A.31}$$

$$T_t = \tau_3 \cdot \Pi_t + \sum_{i=1}^{N} \tau_i^w w_{i,t} + \sum_{i=1}^{N} \tau_i^{WH} WH_{i,t-1} \tag{A.32}$$

$$\Delta GD_t = G_t + dole \cdot \left[\bar{N} - N_t\right] + i_{t-1}^b \cdot GD_{t-1} - T_t \tag{A.33}$$

$$i_t^b = i_{t-1}^b \cdot [1 + \alpha(\frac{B_{B,t}}{GD_t} - \frac{B_{B,t-1}}{GD_{t-1}})] \tag{A.34}$$

Commercial Banks

$$E[r_{i,t}^h] = i_{t-1}^B + \iota i_{t-1}^B \frac{Lh_{i,t-1} + \Delta Lh_{i,t}^*}{yn_{i,t}} \tag{A.35}$$

$$\text{if } m_{i,t}^* < \Psi_t \text{ and } \Delta Lh_{i,t} = \Delta Lh_{i,t}^* \text{ then } r_{i,t}^h = E[r_{i,t}^h] \tag{A.36}$$

$$E[r_t^f] = r_t^f = i_{t-1}^B + \iota i_{t-1}^B \frac{Lf_{t-1} + \Delta Lf_t^*}{Pf_t} \tag{A.37}$$

$$mh_{i,t}^* = E[r_{i,t}^h] \frac{Lh_{i,t-1} + \Delta Lh_{i,t}^*}{yd_{i,t}} \tag{A.38}$$

$$mf_{i,t}^* = E[r_{i,t}^f] \frac{Lf_{i,t-1} + \Delta Lf_{i,t}^*}{Pf_t} \tag{A.39}$$

$$\Psi_t = max\,[\Psi_{min}, min(\Psi_{max}, \Psi^*)] \tag{A.40}$$

$$\Psi^* = \bar{\Psi}_{min} - \frac{NPI}{(\sum_{i=1}^{N} r_{i,t-1}^h Lh_{i,t-1}) + r_{t-1}^f Lf_{t-1}]} + \psi_1 \cdot (k_{B,t} - \bar{k}) \tag{A.41}$$

$$k_{B,t} = \frac{\Omega_{t-1}^B}{[(1-z_t)L_t + B_{B,t}]} \tag{A.42}$$

$$B_{B,t} = GD_t - B_{IF,t} \tag{A.43}$$

$$RL_{B,t}^h t = \sum_{i=1}^{N} (1 - z_{t-1})[r_{i,t-1}^h \widetilde{Lh_{i,t-1}}] \tag{A.44}$$

$$RL_{B,t}^f = (1 - z_{t-1})[r_{t-1}^f Lf_{t-1}] \tag{A.45}$$

$$RB_{B,t} = r_{t-1}^b B_{B,t-1} \tag{A.46}$$

$$\Pi_{B,t} = RL_{B,t}^h + RL_{B,t}^f + RB_{B,t} \tag{A.47}$$

$$ABS_{if,t} = z_t \sum_{i=1}^{N} Lh_{i,t} + z_t Lf_t \tag{A.48}$$

$$z_t = min(1, \frac{ABS_{IF}}{L_t}) \tag{A.49}$$

$$r_t^{abs} = \frac{z_t[(\sum_{i=1}^{N} r_{i,t-1}^h \widetilde{Lh_{i,t-1}}) + r_{t-1}^f Lf_{t-1}]}{ABS_{if,t-1}} \tag{A.50}$$

Investment Funds

$$D_{IF,t} = \eta_{IF} SH_t \tag{A.51}$$

$$q^b_{if,t} = q^b_{if,t-1}\big\{1 - \beta[(r^{cdo}_t - i^B_t) - (r^{cdo}_{t-1} - i^B_{t-1})]\big\} \tag{A.52}$$

$$B^D_{IF,t} = q^b_{if,t} SH_t (1 - \eta_{IF}) \tag{A.53}$$

$$ABS^{*D}_{IF,t} = SH_t(1 - \eta_{IF}) - B_{IF,t} \tag{A.54}$$

$$ABS_{IF,t} = min(z_t L_t, ABS^{D*}_{IF,t}) \tag{A.55}$$

$$RABS_{IF,t} = r^{abs}_{t-1} ABS \tag{A.56}$$

$$RB_{IF,t} = i^B_{t-1} B_{IF,t-1} \tag{A.57}$$

$$RSH_t = RABS_{IF,t} + RB_{IF,t} \tag{A.58}$$

$$rsh_{i,t} = RSH \cdot \frac{sh_{i,t-1}}{SH_{t-1}} \tag{A.59}$$